

Claims

[c1] What is claimed is:

1. A method of multi-slice image acquisition with black blood contrast, the method comprising the steps of:
applying a non-selective inversion pulse in successive R-R intervals;
applying a re-inversion pulse in the successive R-R intervals that is slice-selective over a region encompassing a plurality of slice selections;
timing execution of a series of RF excitation pulses such that signal from blood is near a null point in each R-R interval; and
acquiring data for at least one slice in each R-R interval.

[c2] 2. The method of claim 1 wherein the plurality of slice selections includes two sets of slice selections and further comprising the step of acquiring data for a first set of slice selections in a first R-R interval and acquiring a second set of slice selections in a next R-R interval.

[c3] 3. The method of claim 2 wherein each set includes two slice selections using a fast spin echo readout.

[c4] 4. The method of claim 2 further comprising the step of

alternating data acquisition of the two sets of slice selections until k-space is filled.

- [c5] 5. The method of claim 1 further comprising the step of acquiring more than one slice of MR data per patient breath-hold.
- [c6] 6. The method of claim 5 further comprising the step of acquiring four slices of MR data per patient breath-hold.
- [c7] 7. A pulse sequence for use in multi-slice MR data acquisition comprising:
 - a non-selective inversion pulse applicable to a slab of slices, the non-selective inversion pulse to be applied in each R-R interval;
 - a slice-selective re-inversion pulse applicable to the slab of slices; and
 - a series of spin echo readout excitation pulses applicable to the slab of slices such that MR data with black blood contrast is acquired of the first set of slices during a first R-R interval and of the second set of slices during a next R-R interval.
- [c8] 8. The pulse sequence of claim 7 further comprising a TI period between the re-inversion pulse and the series of excitation pulses in each R-R interval sufficient in length to allow magnetization of blood in the slab to substan-

tially reach a null point before data acquisition.

- [c9] 9. The pulse sequence of claim 7 designed such that MR data for at least one slice in the slab is acquired each R-R interval.
- [c10] 10. The pulse sequence of claim 7 wherein each set includes two slices.
- [c11] 11. The pulse sequence of claim 10 wherein the two slices of the first set are different from the two slices of the second set.
- [c12] 12. The pulse sequence of claim 7 designed such that data for more than one slice is acquired during a single patient breath-hold.
- [c13] 13. An MRI apparatus comprising:
a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and
a computer programmed to apply a pulse sequence having a first and a second inversion pulse during each heartbeat of a successive train of heartbeats and a series of readout excitation pulses during each heartbeat of the

successive train of heartbeats such that at least one slice of data with black blood contrast is acquired during each heartbeat of the successive train of heartbeats.

- [c14] 14. The MR apparatus of claim 13 wherein the first inversion pulse is a non-selective 180 degree pulse and the second inversion pulse is a selective 180 degree pulse designed to re-invert magnetization in a slab containing a plurality of slices.
- [c15] 15. The MR apparatus of claim 14 wherein the pulse sequence is further configured to acquire MR data for multiple slices in each heartbeat of the train of heartbeats.
- [c16] 16. The MR apparatus of claim 15 wherein the slices in a first heartbeat are different from that of a next heartbeat.
- [c17] 17. The MR apparatus of claim 13 wherein the computer is further programmed to apply the pulse sequence such that a plurality of slices of MR data is acquired in a single patient breath-hold.
- [c18] 18. The MR apparatus of claim 13 wherein the pulse sequence further includes a TI period between the re-inversion pulse and the series of excitation pulses in each R-R interval sufficient in length to allow magnetization of blood in the slab to substantially reach a null

point before data acquisition.

- [c19] 19. A computer readable storage medium having a computer program stored thereon, the computer program representing a set of instructions that when executed by a computer causes the computer to:
- generate and cause application of a non-selective inversion RF pulse to a slab of slices during successive R-R intervals;
 - generate and cause application of a slice-selective re-inversion RF pulse to a slab of slices during successive R-R intervals;
 - delay data acquisition in each R-R interval by an inversion time sufficient to allow magnetization of blood within the slab to substantially reach a null point;
 - apply a series of RF excitation in each R-R interval; and
 - acquire MR data for at least one slice in the slab in each R-R interval.
- [c20] 20. The computer readable storage medium of claim 19 wherein the set of instructions further causes the computer to acquire data for two slices in the slab in each R-R interval.
- [c21] 21. The computer readable storage medium of claim 20 wherein the two slices of a first R-R interval is different from the two slices of a next R-R interval.

- [c22] 22. The computer readable storage medium of claim 21 wherein tissue for each slice in the slab is excited during every other R-R interval.
- [c23] 23. The computer readable storage medium of claim 19 wherein the set of instructions further causes the computer to acquire more than one slice of MR data in a single patient breath-hold.
- [c24] 24. The computer readable storage medium of claim 23 wherein the more than one includes four slices of data in a single patient breath-hold.
- [c25] 25. A computer data signal embodied in a carrier wave and downloadable/uploadable to an MR imaging system, the signal representing at least a pulse sequence to be carried out for MR data acquisition with black blood contrast by the MR imaging system, the pulse sequence having:
- a non-selective inversion pulse to be carried out in each R-R interval of a train of R-R intervals;
 - a slice-selective re-inversion pulse to be carried out after the non-selective inversion pulse in each R-R interval; and
 - a set of excitation pulses to be applied in each R-R interval such that MR data may be acquired for at least one

slice in a slab during each R–R interval.

- [c26] 26. The computer data signal of claim 25 wherein the pulse sequence further includes an inversion recovery time in each R–R interval sufficient to allow magnetization of blood within the slab to substantially reach a null point.